RISK MANAGEMENT PLAN

FORMER GLOUCESTER LANDFILL

Revised 2007
(Final)

Prepared for
Transport Canada
Ottawa, Ontario

Prepared by
Franz Environmental Inc.
329 Churchill Ave North, Suite 200
Ottawa, Ontario
K1Z 5B8

March 2007

Steve Livingstone, M.Sc., P.Geo.

The enclosed report titled:

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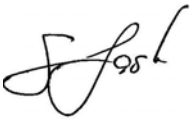
This document as been reviewed by Steve Livingstone (Project Manager), as to form and content.



Steve Livingstone, M.Sc., P.Geo.

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LIST OF ABBREVIATIONS/ACRONYMS

COPC(s)	Chemical(s) of Potential Concern
EMU	Environmental Management Units
LCP	Leitrim/CP Rail Plume
MWP	Municipal Waste Plume
Plan	Risk Management Plan
RBTC	Risk-Based Target Criteria
SWP	Special Waste Plume
TCFM	Trichlorofluoromethane
1,1,2 TCTFE	1,1,2 Trichlorotrifluoroethane
VC	Vinyl Chloride

1.0 INTRODUCTION

The Risk Management Plan (RM Plan) for the Former Gloucester Landfill was developed as a result of the *Former Gloucester Landfill Area Wide Risk Assessment* (FRANZ, 2003) and the *Supplemental Risk Assessment for the Proposed Future Growth Area East of Albion Road* (FRANZ, 2002). The RM Plan was updated following the completion of a natural attenuation study of the Municipal Waste Plume (MWP) (FRANZ, 2007). Evidence of natural attenuation of contaminants (i.e., target chlorinated compounds) in the MWP were observed and a recommendation to gradually implement Monitored Natural Attenuation (MNA) as a remedial option for the MWP in lieu of the operation of the shallow extraction wells was formulated.

The RM Plan was updated to include the required long-term MNA performance monitoring program for the MWP. This Plan provides the strategy to monitor, control, and prevent exposure to contamination with respect to the former Gloucester Landfill site and off property receptors.

It should be noted that health risks to the full-time workers operating the Gloucester Landfill treatment facility and short-term maintenance/delivery workers are addressed by the facility health and safety protocols, including Hazardous Materials/Waste Inventory and Management Plan, and are therefore not covered under this Plan.

1.1 Risk Management – Overview

A simplified flow chart of the Plan is provided as Figure 1-1. This figure provides a simple model of the main elements of the RM Plan, the roles of the Area Wide Risk Assessment, the ongoing remediation (e.g., groundwater pump and treat system and MNA), and risk management measures. Other significant historical activities and risk management measures (e.g., partial soil removal, fencing) have been included in the Plan, as these activities have contributed to the risk management of the Study Area.

As shown on Figure 1-1, risk management encompasses the whole range of activities such as risk assessment, risk reductions and controls, and monitoring features. Within the Risk Management Plan, active remediation removes and controls contaminants from the affected media. Natural processes, such as natural attenuation, and engineered systems, such as the pump and treat system, can contribute to the removal and control of contaminants.

The terms and uses of risk management, risk assessment and remediation are often confused and require clarification. The definitions are as follows:

> **Risk Management** – the selection and implementation of a strategy for control of risk (the level of risk having been defined by means of a risk assessment), followed by monitoring and evaluation of the effectiveness of that strategy; it may include direct remediation or other strategies that reduce the probability, intensity, frequency, or duration of the exposure to contamination. Over time the cycle is repeated as the body of scientific knowledge evolves and creates a need to review the validity of the formulated/defined problem.

Risk Assessment - The combining of data and information on health hazard (contaminants) with data and information on exposure pathways to evaluate potential risks to human health and ecological receptors. Risk Assessments may form part of an overall Risk Management Plan.

Remediation – the improvement of a contaminated site to prevent, minimize or mitigate damage to human health or the environment; remediation involves the development and application of a planned approach that monitors, removes, destroys, contains or otherwise reduces the exposure of contaminants to receptors of concern. Remediation typically involves the active physical or chemical removal of a contaminant from soil, sediment, groundwater or other media. Remediation can also include the monitoring of natural attenuation. Naturally occurring processes have the ability to reduce contaminant concentrations in soil and groundwater. In the context of contaminated sites, this is referred to as remediation by Monitored Natural Attenuation (MNA) or intrinsic remediation.

A risk management plan provides an action or strategy to reduce, control or prevent exposure to contamination with a goal of reducing the risk to an acceptable level. This typically involves controlling or eliminating one or more risk components namely: contaminants, receptors or exposure pathways. Within the risk management plan, a risk communication plan is developed and implemented to ensure that the risk management results, monitoring and controls are communicated to the appropriate stakeholders.

1.2 Purpose and Objectives

The purpose of this RM Plan is to provide an on-going systematic framework to monitor, assess, reduce and control, prevent, and communicate risks using reasonable, practical and feasible efforts at protecting human and ecological receptors. The intention of this RM Plan is to provide the framework and benchmarks for the successful administration of the property.

The risk management objectives within the RM Plan are:

1. To address a clearly defined problem in order to prevent a risk to human health and the environment;

2. To be consistent with the risk management measures, as defined by the Ontario Regulation 153/04 (MOE, 2004), already implemented at the site (i.e., the pump and treat remediation system);

3. To provide a strategy that incorporates activities for monitoring, controlling and preventing risks that:

    - Are based on best available scientific and technical information and evaluation;
    - Account for a variety of pathways and receptors;
    - Are feasible with benefits being reasonable relative to cost;
    - Include a priority for preventing and reducing risks, not just controlling risks; and
    - Consider innovation, evaluation and research.

4. To provide a Contingency and Risk Reduction Plan, if required;

5. To provide a decision making process by way of Risk Communication; and

6. To be revised and modified when significant new information (e.g., chemical analyses; toxicological data) becomes available. Thus the RM Plan is considered a "Living Document" that can be appropriately revised as required.

1.3 Gloucester Landfill Risk Management Plan – Problem Formulation and Strategy Outline

For the Study Area, it is important to ensure that any substances associated with the former Gloucester Landfill, which are present in groundwater, continue to not present a risk to off-property receptors (human and ecological). A site-specific problem formulation has been defined to ensure a clear understanding of the main issues and protection strategy.

1.3.1 Problem Formulation - Definition

The results of the Area Wide Human Health and Ecological Risk Assessment (FRANZ, 2003) indicated that the existing environmental conditions within the Former Gloucester Landfill site area do not represent a risk to human health and ecological receptors. Substances (i.e., vinyl chloride, TCE, PCE, 1,1 DCE, cis-1,2 DCE, benzene, diethyl ether, tetrahydrofuran and 1,4-dioxane) have been detected in the shallow and deep groundwater, surface water and/or soil vapours downgradient from the Gloucester Landfill site. The concentrations of these substances in the groundwater, surface water and soil vapour are well below the concentrations that may present a potential risk to current and future receptors.

The RM Plan has been developed to:

- Monitor, evaluate and analyze for the "Gloucester List" of chemicals of concern (primarily chlorinated solvents) in both surface water and shallow and deep groundwater;

- Monitor, evaluate and analyze for the "natural attenuation indicators" in the MWP to verify the effectiveness of the MNA remedial option;

- Ensure the protection of human health from exposure to impacted groundwater or surface water by means of ingestion or dermal contact;

- Ensure the protection of human health from exposure to chemical vapours which made their way from the groundwater to indoor air, considering current residential and commercial settings and also, for future occupants; and

- Ensure the protection of ecological receptors from uptake of impacted groundwater and surface water.

The RM Plan also provides administrative risk management measures to address issues relating to the area where historical landfilling activities were carried out for municipal and special wastes. Consideration is given to ecological and human health impacts, the latter focused on ingestion and dermal contact as two routes of exposure.

1.3.2 Risk Management Strategy

At the onset of the RM Plan and within the AWRA, the Study Area was sub-divided into five Environmental Management Units (EMUs). The concept of EMUs is important for the longer-term exit strategy, as EMUs can be closed during the project life based on satisfying pre-determined criteria.

Within the Plan, two main activities (Site Monitoring and Risk Management measures) have, or will be, completed to provide a level of protection to human health and the environment, which is consistent with the regulatory requirements. A Contingency and Risk Reduction Plan is also proposed and would be implemented if further reduction measures were required. Finally, a Risk Communication Plan, consistent with past activities, is provided in this overall RM Plan.

The RM Plan outline is provided in the following sections. It is important to acknowledge that Transport Canada has implemented much of this plan. This includes regular groundwater and surface water monitoring programs, site inspections, ongoing environmental subsurface investigations, exposure risk management measures including fencing and the operation of the groundwater pump and treat system.

1. Risk Management Measures

The site-specific risk management measures for the property will be accomplished by providing: 1) physical, chemical, or natural barriers to exposure (e.g., groundwater treatment system, and natural attenuation processes), and 2) administrative controls (e.g., drinking water well uses).

Additional Administrative Controls have been identified and will be considered in the Risk Management Plan.

2. Site Monitoring Activities

Site monitoring activities are required to ensure that the exposure pathways are not operable and/or to verify that the receptor(s) have not been impacted. Site monitoring activities are also required to verify the effectiveness of the MNA remedial option. Two types of monitoring will be completed at the property namely: active and passive monitoring.

A. Active Monitoring Program: Groundwater and surface water sampling locations will be utilized to evaluate the on and off-property conditions, current and future, in comparison to the risk-based environmental quality criteria.

Risk-based groundwater and surface water chemical target concentrations will be used to evaluate the ongoing protection of human health and the environment. The target concentrations were initially developed as an outcome of the AWRA.

The active monitoring program will also include performance monitoring for the MNA remedial option.

B. Passive Monitoring or Site Inspection Program: A Site Inspection monitoring program will be utilized to ensure the integrity of risk management measures (e.g., fencing and integrity of landfill capping material) and confirm that the environmental conditions have not changed.

3. Contingency and Risk Reduction Plan

A Contingency and Risk Reduction Plan will be formalized, as part of the Risk Management Plan, and would be implemented if additional risk reduction measures are required.

4. Risk Communication Plan

A Risk Communication Plan has been active, for a number of years, to provide local residents and other stakeholders with regular updates to the progress of the management of the property. Further, additional communication links to the City of Ottawa, Ottawa Macdonald-Cartier International Airport and the Ontario Ministry of Environment have been updated.

2.0 RISK MANAGEMENT MEASURES

The site-specific risk management measures for the property have, or will be, accomplished by providing:

- Physical controls and exposure pathway barriers (e.g., groundwater treatment system, and natural attenuation processes) and
- Administrative controls (e.g., groundwater use advisory; health and safety programs).

Reviews of the risk management measures that have been implemented within the Study Area are provided in the following section.

2.1 Physical Controls and Exposure Pathway Barriers

Significant work has been completed at the Gloucester Landfill to control exposure pathways and reduce the risk to human and ecological receptors, as listed below. These ongoing controls, except for the soil remediation, will remain in place until it is determined that these activities are no longer necessary.

- **Surface Cover:** Following the closure of the Gloucester Landfill site, the landfilling area was covered with a soil cover and re-vegetated. Currently, the landfill area has a well vegetated and stable cover with grasses, shrubs and a woodlot. This cover provides an effective barrier to direct chemical exposure to the buried waste materials.

- **Partial Soil Remediation:** From 1987 to 1989, impacted soil and waste materials were removed from the Special Waste Compound and disposed off-property at licensed waste treatment disposal facilities in Ontario.

- **Deep Groundwater Plume Control and Removal:** A groundwater treatment facility was constructed and treatment began in April 1992. Impacted groundwater is pumped from a number of deep groundwater extraction wells to a groundwater treatment facility. This water is subjected to an enhanced photo-oxidation process to destroy the majority of the organic chemical constituents of concern. The treated groundwater is then re-injected into the subsurface, via a lagoon. This treatment system provides for the reduction and containment of the dissolved phase chemicals in groundwater.

- **Shallow Groundwater Plume Control and Removal:** The groundwater treatment facility constructed in 1992 also includes a number of shallow extraction wells. As presented in the natural attenuation study of the MWP (FRANZ, 2007), it is proposed to gradually shut-down the shallow extraction wells and implement Monitored Natural Attenuation as a long-term remedial option for the mass removal of contaminants in the MWP. In the future selected wells may be shut-down based on further analysis.

2.2 Administrative Controls

Administrative controls will be employed to ensure that any long-term risk reduction measures remain in place and that there is effective communication of the Risk Management Plan. Many of these measures are managed by Transport Canada, however additional controls fall under Municipal, or Provincial (MOE) jurisdiction. The following controls have been considered in this Risk Management Plan:

- **Safe Drinking Water Supply:** In 1984 and 1985, local groundwater supply wells were taken out of service and municipal water service (from the Ottawa River) was provided to this area to ensure a safe water supply for homes and businesses already existing in the area.

- **Fencing and Access Restrictions:** A fence was installed around the perimeter of the Special Waste Compound to restrict the access to the property. Additional fencing around the plant and at the control gate was placed at the main entrance at Leitrim Road to restrict vehicle traffic from accessing the site.

- **Health and Safety Plans:** Though this is beyond Transport Canada's control, project and company specific Health and Safety plans should be implemented for construction or maintenance personnel working in certain locations of the Study Area. The Risk Management Plan would seek to increase the awareness of employers to the site conditions, which may require a H&S plan.

  During construction and maintenance activities (including workers installing below grade services such as gas or electricity) within the Study Area, a Health and Safety Plan (Plan) for construction and maintenance workers should be followed. The Health and Safety Plan is the responsibility of the employer (of the specific project). A Plan should be developed to cover the environmental conditions to which a construction and maintenance worker may be exposed. Hygienic precautions would be provided by this Plan to prevent or minimize exposure (if applicable). These exposure controls could consist of appropriate personal protective clothing, work practices, and personal hygiene practices.

- **Provincial and Municipal Controls:** Provincial and Municipal controls should be used to block or mitigate potential exposure pathways.

  These controls are required to ensure that the Study Area does not change in a way that would create pathways for receptors that were not considered. The Infrastructure Services Branch (Right-of-Way Management) is the point of contact within the City of Ottawa for any work conducted in the City of Ottawa's right-of-way (e.g., Road Cut Permit). The Building Services Branch (Permit Approvals) is concerned with work carried out at depth on private properties in preparation for building of a structure (e.g. Building Permit). Municipal or local government controls include:

- Maintain a municipal drinking water supply in this area.
- Soil management plans in the event of future deep excavations into the watertable.
- Recommendations for design, installation and maintenance of utility service lines.
- Worker health and safety programs.

Communication and information links have or will be made with the appropriate Ministry of Environment personnel and the development services within the City of Ottawa.

- **Documentation and Record Keeping:** The procedures are in place to ensure proper chain of reporting, evaluation and interpretation of data, and filing of results for third-party review. It is anticipated that all monitoring, sampling results and risk management measures will be communicated, as a minimum in the Annual Report (or monthly report) prepared by Transport Canada and shared with the Gloucester Landfill Technical Advisory Committee which includes representatives from the City of Ottawa – (including the Public Health Division); Environment Canada; Health Canada; the Ontario Ministry of Environment; Public Works and Government Services Canada; and Transport Canada.

3.0 SITE MONITORING ACTIVITIES

The main goal of any monitoring program is to provide an indication of the degree of impact over time and provide a system to evaluate chemical trends and potential impacts. An active groundwater and surface water monitoring program has been developed upon which future risk management decisions, if needed, can be based. This plan will effectively provide an early detection system that can be used and implemented in concert with the Contingency and Risk Reduction Plan (Chapter 4). Further, a site inspection program will be completed to ensure the integrity of risk management measures (e.g., integrity of landfill capping material).

The groundwater and surface water monitoring program has a number of components including the presentation of: risk based environmental quality criteria, target, performance, and trend sampling locations and data analysis and interpretation. The following section provides a detailed review of these main components.

3.1 Risk-Based Target Criteria

Risk-Based Target criteria (RBTC) have been established to formalize the performance objectives and reporting requirements as part of the RM Plan. Target criteria represent baseline values to which the results of the monitoring program can be compared. The Target criteria have been generated from the Risk Assessment studies (FRANZ, 2002 & 2003) and from most up to date toxicological information. The detailed rationale is provided under separate cover in *Former Gloucester Landfill Site, Risk-Based Environmental Quality Criteria, Updated October 2003.* The RBTC are listed in Table 1-1.

Health Canada has recently revised the drinking water guidelines for trichloroethene (HC, 2005). The Gloucester Landfill site has been previously recognized by the TAC as a non-potable groundwater environment (FRANZ, 2003). As such, the new Health Canada guidelines are not applicable to the site. However, it is expected that the revised toxicological information provided in the Health Canada drinking water guidelines will be transferable to other exposure pathways applicable to the Gloucester Landfill site, such as indoor air inhalation. Consequently, the federal and provincial jurisdictions are likely to provide revisions to the non-potable quality standards. Transport Canada should be prepared to revise the RBTC for TCE should a new non-potable standard/guideline be released.

3.2 Target, Performance and Trend Sampling Locations

For this RM Plan, a limited number of stations were selected as Target well/surface water monitoring stations. A set of wells was selected to monitor the performance of the MNA (Performance Wells). Other groundwater sampling locations were selected in order to evaluate ‘trends’ in the concentrations of target compounds over time (Trend sampling locations).

3.2.1 Target Monitoring Wells/Stations

Target groundwater monitoring wells or surface water stations will be used in this RM Plan to compare the chemical concentrations to the RBTC developed for the Study Area (Section 3.1). The Target monitoring stations were selected to ensure the protection of human health and the environment and act as an early warning system.

The Target groundwater monitoring stations are presented on Figure 1-2 and listed in Table 1-2. The Target surface water monitoring stations are presented on Figure 1-3 and listed in Table 1-3. The Target monitoring stations were selected considering the following factors:

- Monitoring stations should be located on Transport Canada property or along rights-of-way,
- Monitoring stations should be representative of all four environmental zones defined in the SRA and AWRA (FRANZ, 2002 & 2003),
- Monitoring stations should be representative of all three plumes defined in the SRA and AWRA (FRANZ, 2002 & 2003), and
- Monitoring stations should provide a good historical concentration trend, be well maintained and be capable of providing representative groundwater samples.

3.2.2 Performance Monitoring Wells

Performance monitoring wells will be used to monitor the effectiveness of the MNA option. Six wells were selected within the MWP area and one well was selected as being representative of background conditions for the MWP, as shown on Figure 1-2. The performance wells will be utilized to verify that conditions remain suitable for natural attenuation processes, degradation of parent compounds is occurring down to non-hazardous by-products, and that the production of more toxic by-products (e.g., VC) from the parent compounds (e.g., TCE) is maintained at a level protective of human health and the environment. The performance wells were selected to evaluate:

- Potential changes in parent/daughter molecular ratios in the MWP;
- Potential changes in concentration of cVOC in the MWP;
- Potential changes in reductive conditions in the MWP;
- Possible reduction in number of shallow extraction wells in operation as more evidence that natural attenuation processes are sufficient to be protective of human health and the environment is collected.

3.2.3 Trend Monitoring Wells/Stations

Trend monitoring wells will be used to evaluate changes in the groundwater concentrations and will be used as an early detection system. The selected trend wells are located at strategic groundwater locations and include the shallow and deep (including Bedrock) Special Waste (SWP), Municipal Waste (MWP) and Leitrim/CP Rail (LCP) groundwater plume(s), within the chemical source areas and near the groundwater pump and treat extraction and injection wells.

All data from these wells will be plotted after each monitoring event in order to evaluate trends. The same factors considered in the selection of the Target monitoring wells were applied to the selection of the Trend monitoring stations. The Trend groundwater monitoring stations are presented on Figure 1-2 and listed in Table 1-2. The trend monitoring stations were selected in order to evaluate:

- Potential changes in the deep Special Waste Compound (SWC) plume,
- Potential changes in the shallow SWC plume,
- Potential changes in the shallow municipal waste plume (MWP), and
- Potential changes in the shallow Leitrim-CPR plume (LCP).

3.3 Environmental Management Units

The concept of Environmental Management Units (EMUs) is important for the longer-term exit strategy. Five EMUs of environmental significance were defined for the Study Area based on the local hydrogeology, chemical database and chemical populations, hydrochemistry and human and ecological receptors (see Figure 1-4). Each EMU encompasses a specific group of monitoring stations (see Table 1-4). These sampling locations provide the chemical data sets specific to each EMU.

The site monitoring and control measures sections identify the evaluation criteria that will be used to determine the status of the EMU, future work or closure with no further action required.

3.4 Groundwater and Surface Water Sampling and Data Analysis

3.4.1 Sampling Requirements

The sampling and analysis program for the target, performance, and trend wells or surface water stations was developed around the following assessments:

- The groundwater and surface water at the target, performance and trend stations will be analysed for all 18 compounds present on the RBTC list (Table 1-1). Note that m-xylene and p-xylene are reported as total m,p-xylene concentration and are therefore referred to as a single substance.
- The groundwater at the performance wells will be analysed in the field for dissolved oxygen (DO), oxidation-reduction potential (ORP), and pH. Groundwater samples will be collected from the performance wells and submitted for analysis of ammonia, nitrite, nitrate, ferrous iron, sulphate, sulphide, and alkalinity concentrations.
- The groundwater monitoring target, trend, and performance stations will be monitored at a minimum once a year in accordance with the monitoring program already in-place. The surface water Target monitoring stations will be monitored at a minimum once a year, in the early spring after most of the snow melt run-off (e.g., May).
- Additional data requirements for assessment include:

  - Groundwater elevation measurements and flow direction interpretation;
  - Record of changes in landuse, knowledge of spills, construction activities or modifications to the land use, which may affect the groundwater conditions.
- Chemical analyses of the surface water and groundwater target, performance and trend wells/stations will be performed at the Gloucester Landfill laboratory facilities. This lab undergoes specific QA/QC protocols and third-party review consistent with external laboratories. Selected samples will be submitted to third-party laboratories as part of the QA/QC program.
- Sampling will be conducted with appropriate QA/QC and chain of custody protocols.

The selected specific chemical parameters and sampling frequency will be reviewed yearly and revised when needed based on changes in historical trends, chemicals of concern and groundwater flow velocities (shallow and deep aquifers).

3.4.2 Data Evaluation and Interpretation

3.4.2.1 Target Monitoring Wells/Stations

The data interpretation of the groundwater and surface water Target wells/stations will consist of two tasks:

1. First, individual groundwater and surface concentrations will be reported and compared to the RBTC. Significant concentration increase between two sampling rounds (i.e., outliers) will be considered in the single data interpretation. Closer examination of outliers, followed by a confirmatory sampling program as required, will be completed if the data indicate a significant increase in risk level.

2. Secondly, the RBTC will be compared to a moving average calculation of a minimum of three samples collected over a period of three years (see example of moving average calculations in Appendix A). If the moving average interpretation indicates an increase in monitored parameters with concentrations exceeding RBTC, various risk assessment and risk reduction measures will be implemented through a contingency plan (Section 4.0). The initial sampling and interpretation under this Plan will include the historical database such that these concentrations can be incorporated into the moving average calculation. The moving average procedure is based on the following study and site conditions:

    - The potential health risks as described in the Supplemental Risk Assessment and the Area Wide Risk Assessment (FRANZ, 2002 & 2003) were determined by directly comparing the estimated concentration of substances in air to which humans may be exposed to toxicity reference values (TRVs). The TRVs define the concentrations of substances in air to which humans, including children may be exposed continuously for a lifetime without any likelihood of adverse health effects. Thus the moving average calculation considers that the risks are based on a long-term, not acute, exposure by

receptors. A single chemical analysis over the target concentration does not necessarily pose a health risk.

- Seasonal fluctuations in the chemical concentrations will occur as a result of natural seasonal variations in groundwater recharge, dilution and mixing. The data evaluation based on the moving average calculation will be completed to account for the seasonal variations. Individual anomalous concentrations will be investigated and monitored.

3.4.2.2 Performance Monitoring Wells

The data interpretation of the groundwater performance monitoring wells will consist of four tasks:

1. Evaluating the presence of favourable conditions for reductive dechlorination, the predominant natural attenuation mechanism, of the cVOCs through the analysis of parameters listed in the table below. Favourable biodegradation conditions are indicated by relative differences between the conditions observed within the core of the plume, the fringe of the plume, and outside of the plume, as provided:

	Maximum Located	Indicate Favourable Conditions for Biodegradation?
pH	Fringe of plume	Yes. Depressed pH in the core of plume indicates favourable conditions for reductive dehalogenation of parent compounds.
Oxidation-reduction potential (ORP)	Fringe of plume	Yes. Low ORP in the core of plume indicates favourable conditions for reductive dehalogenation of parent compounds.
Dissolved Oxygen (DO)	Fringe of plume	Yes. Low DO in the core of plume indicates favourable conditions for reductive dehalogenation of parent compounds.
Ammonia (NH_3)	Core of plume	Yes. Elevated ammonia in the core of plume indicates favourable conditions for reductive dehalogenation of parent compounds.
Nitrite (NO_2^-)	Core of plume	Yes. Elevated nitrite indicates utilization of nitrate as an electron acceptor in the biodegradation process of parent compounds.
Nitrate (NO_3^-)	Fringe of plume	Yes. Low nitrate in the core of plume indicates favourable conditions for reductive dehalogenation of parent compound
Ferrous Iron (Fe^{2+})	Core of plume	Yes. Elevated Fe^{2+} in the core of plume indicates favourable conditions for reductive dehalogenation of parent compound
Sulphate (SO_4^{2-})	Core of plume	Yes. Elevated concentrations in the core of the plume combined with lower concentrations in the fringe indicate that sulphate is utilized following the utilization of nitrate in the core of the plume in sequential order to assist the degradation of the parent compounds.
Sulphide (HS^-)	Core of plume	Yes. Elevated sulphide in the core of the plume indicates favourable conditions for the reductive dehalogenation of parent compounds.
Alkalinity	Core of plume	Yes. Alkalinity can be increased through the production of CO_2 from biodegradation of parent compounds.

2. Confirming that natural attenuation mechanisms are active through the evaluation of concentration trends and molecular ratios of TCE (parent) and cis-DCE and VC (daughter).

Steady or decreasing concentrations of these three compounds should be observed over time. The ratios should indicate greater concentrations of parent compound in the core of the plume (i.e., at 146 and 384) relative to the daughter compounds. The opposite relationship should be observed in the monitoring wells located towards the edge of the plume (i.e., 352 and 307).

3. Confirming that the production of more toxic daughter products remain at a level protective of the receptors. This will be done through comparing the concentrations of cis-DCE and VC measured at the target, performance, and trend monitoring stations against the RBTC.

4. Updating the natural attenuation conceptual model presented in (FRANZ, 2007) to confirm the natural attenuation potential of the MWP. Evaluating the contribution of the shallow extraction wells and the natural attenuation processes to the overall mass reduction in the MWP. Evaluate whether natural attenuation requires to be supplemented by the shallow extraction wells in order to maintain mass reduction protective of the receptor along Del Zotto Avenue. If not, evaluating the possible reduction in number of active shallow extraction wells based on increased evidence that natural attenuation alone can sustain sufficient mass loss.

3.4.2.3 Trend Groundwater Monitoring Wells

The groundwater concentrations in the Trend Wells/Stations will be compared to those in the historical database to evaluate changes in the groundwater concentrations. This will serve as an early detection system to identify potential increase in risk level.

The data interpretation will also review the following primary trends:

- Groundwater chemical concentrations in bedrock, deep or shallow units, especially downgradient of shallow and/or deep extraction wells network,
- Groundwater concentrations at the limits of Transport Canada property, and
- Changes in plume behaviour (transient, horizontal and vertical conditions).

3.4.2.4 Environmental Management Units

It is not a condition of the Plan that any or all control measures including the groundwater pump and treat system remain indefinitely in operation. Rather, it is required that the groundwater or surface water concentrations remain within the prescribed RBTC. As such, the requirements of an active remedial system may not be required, as the chemical concentrations at the source and down gradient become attenuated over time and no significant chemical rebound effect is observed. The termination of the Monitoring Plan for each EMU will be evaluated against the following criteria:

1. Are the chemical results consistently below the appropriate RBTC over the past 5 years?

2. Do the chemical results demonstrate a trend of reduced or steady state concentrations over the past 5 years?
3. Have the pathways and/or receptors identified in the risk management plan been modified or eliminated?

If these criteria have been met then the monitoring plan can be terminated. The EMU status would be considered as "No Further Action Required".

3.4.2.5 Interpretation Methodology Outlines

The fundamental aspects of the data interpretation methodology include:

- Examination of outlier concentration (e.g., peak concentration) from any single groundwater or surface water detection and implementation of a confirmatory sampling program if the data indicate a significant increase in risk level (e.g., single concentration higher than RBTC).
- Comparing groundwater concentrations (using moving average calculation) in Target Wells to the appropriate RBTC (Table 1-1).
- Reviewing the groundwater concentrations in Trend Wells to those in the historical database to evaluate changes in the groundwater concentrations and in natural attenuation activities in the MWP.
- Comparing surface water concentrations (using moving average calculation) to Ecological RBTC (Table 1-1).
- Assessing the performance of the natural attenuation processes in the MWP.
- Assessing general groundwater flow directions and contaminant transport properties with the use of groundwater elevation measurements and chemical distribution.
- Assessing the EMUs status: "Active" or "No Further Action Required".
- Utilize standard Chain of Custody and field sampling data sheets.

The data interpretation and reporting of the trend, performance and trigger wells will be provided as a section in the Annual Report. Monthly data reports will also be completed, as per the previous reporting structure.

3.5 Site Inspections

A site inspection monitoring program will continue, as per previous yearly activities, to ensure the integrity of the risk management measures, confirm that the environmental conditions have not changed and confirm that aspects of the Risk Management Plan have been administered. This activity will include the inspection of the following:

- Special Waste Compound fencing;
- Treated groundwater lagoon fencing;
- Municipal landfill capping material and vegetation;
- Front gate fencing and vehicle control; and

- Trespassing and other prohibitive land use control.

4.0 CONTINGENCY AND RISK REDUCTION PLAN

4.1 Site Monitoring and Site Inspection - Response Criteria & Response Actions

As provided in Section 2, the target groundwater well and surface water concept will be used to ensure the ongoing protection of human health and environment. The interpretations of the data will use: 1) single detection concentrations and, 2) moving average concentrations. The single detection concentrations will be examined and a confirmatory sampling program will be implemented if the data indicate a significant increase in risk level (e.g., single concentration higher than RBTC). The moving average concentrations will be based on a minimum of three samples collected over a period of 3 years. Results of the monitoring plan will be compared against the RBTC to provide continuous feedback for hazard identification and maintenance of the property within the Risk Management Plan.

Monitoring results that have the potential to modify the outcome of the Risk Management Plan are referred to as response criteria. The response actions are generally designed to confirm the findings of the monitoring programs and to take appropriate contingency measures should the findings be confirmed. For example, the results of a monitoring program may identify a statistical increase in one or more parameters. This specific response criterion may trigger a series of response actions aimed at confirming the observed trend. The response actions will include a re-evaluation of the validity of the monitoring data and re-evaluation of the risk management assumptions.

A summary of some response criteria and response actions are provided as follows:

Response Criteria and Corresponding Response Actions

Response Criteria	Response Action
Decrease in monitored chemical concentrations with concentrations below RBTC	• Decrease sampling frequency • Consider reductions in sampling locations • Review monitoring data to show that EMU has met closure criteria
Increase in single detection monitored chemical concentrations but with concentrations remaining below RBTC	• Re-evaluate monitoring data • Consider possibility of impact by other sources • Increase sample frequency to determine absence/presence of statistical increase
Increase in single detection monitored chemical concentrations above RBTC	• Re-evaluate monitoring data • Implement confirmatory sampling program • Consider possibility of impact by other sources
Increase in moving average monitored concentrations with results exceeding RBTC	• Re-evaluate risks through Risk Assessment update • Determine if the pathways and/or receptors identified in the risk assessment been modified or eliminated • Develop plan of action; possible plan could require the following: * Increase monitoring frequency * Development of additional risk management measures (e.g., extraction wells)
Decrease in natural attenuation potential or increase in biodegradation toxic by-products.	• Evaluate the possibility of enhancing biodegradation activities through addition of bio-stimulants • Re-instatement of all or part of the shallow extraction well system associated with the MWP
Breach of Fencing or Landfill Cover Material	• Complete modifications and repairs to fencing • Add landfill cover
Increase in Trespassing	• Re-evaluate site access plan • Incorporate new fencing, signage for reducing trespassing
Change in off-property land use (to more sensitive receptor)	• Re-evaluate validity of monitoring plan • Re-evaluate changes in risk assumptions on site management
Change in off-property exposure pathways (to more sensitive receptor)	• Confirm operable vs. non operable pathways to receptors • Re-evaluate validity of monitoring plan • Re-evaluate changes in risk assumptions on site management

4.2 Active Contingency Plan and Risk Reduction

A Contingency Plan would be implemented, if further risk reduction were required to prevent or control exposure to the chemicals and would be defined according to the response

criteria/response actions. This section is not meant to be prescriptive, as a case-by–case evaluation is required to provide the necessary control or preventative measure.

A Contingency Plan will be developed following the observations and results obtained from the data evaluation and interpretation results. A Contingency Plan will be site-specific and based on the protection of human health and the environment. The Contingency Plan will have specific requirements and performance based design criteria. The plan could contain the following work items or tasks:

- Dedicated sampling plan for a specified period;
- Installation of additional downgradient monitoring wells;
- Re-instatement of all or part of shallow extraction well system associated with MWP;
- Active or passive chemical treatment, collection or recovery;
- Active or passive source risk management measures; and
- Additional administrative controls.

A separate reporting file, outside of the standard yearly or monthly reporting structure would be required for this part of the Risk Management Plan.

5.0 RISK COMMUNICATION

Risk communication procedures are required to ensure that the risk management results, monitoring and controls are communicated to the appropriate stakeholders. The plan consists of formalizing direct links to responsible parties; providing updated results to local residences and businesses and a review process.

5.1 Links to Accountable Parties

A link has been made to the development services within the City of Ottawa responsible branch. This link will ensure proper acknowledgement of site conditions within and adjacent to the Gloucester Landfill site. This would likely apply for building permits, road-cut permits and service work (e.g., watermain/utility work) by city personnel and other private contractors.

Communication links have been established with the appropriate staff at the Ontario Ministry of Environment to ensure that notice is provided regarding the potential issues with the use of domestic water wells downgradient from the landfill.

5.2 Local Public Consultation Plan

The public consultation plan consists of a three-tiered approach as follows:

- **Answer – Response**. Transport Canada ensures accurate and timely delivery in answering questions from the public and distribution of annual reports when requests are received. Reports are made available to the public upon request.

- **News Updates**: Transport Canada ensures that a letter is sent to all residents and businesses, every second year, which provides an update of progress at the former Gloucester Landfill Site. In the past, the former steering committee met with a resident's committee to discuss issues. In addition, Transport Canada sends out sampling results annually to owners of land that have active monitoring wells on their property.

- **Site Tours and Exhibitions:** Guided Tours on request are offered at the treatment facility.

5.3 Review Process

The Risk Management Plan will be reviewed on an annual basis in concert with the Annual Operations and Subsurface Monitoring Report prepared for Transport Canada.

The review will focus on a number of elements in the Risk Management Plan including:

Rationale for the Risk-Based Target Criteria

Rationale for the Risk-Based Target criteria will be reviewed, on an annual basis to ensure that the criteria are appropriate, given the best information available at that time. For instance, this may include a review of the toxicity values and identification of new toxicity reference values for

any of the substances of potential concern. Alternatively, new site-specific criteria could be developed or a re-evaluation of the site-specific risk assessment calculations could be conducted if there is a significant change in landuse and receptor type or location.

Review of Target and Trend Wells/Stations

The location and monitoring of the target and trend wells and stations will be reviewed on an annual basis to ensure proper locations and effective monitoring is being conducted.

Review of Contingency Plan and Risk Reduction Methods

This plan provides a method to review, prevent and reduce risks from occurring, not just controlling risk. As such, any additional risk reduction methods will be reviewed on an annual basis (e.g., pump and treat optimization, introduction of barriers (fencing) etc). This includes revisions to the management strategies for the various plumes including the adoption of MNA for the management of the MWP.

Land use or Receptor Changes

An annual review of the local land use and the receptors will be completed to ensure adequate protection of receptors. This review will also determine if all risk management assumptions remain applicable. The City of Ottawa and the Ottawa Macdonald-Cartier International Airport will be included in this review (new buildings and leases)

Record Keeping and Document Review

All records and documents be compiled and centralized on a yearly basis.

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6.0 REFERENCES

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Ministry of Environment, 2004. Records of Site Condition. A Guide on Site Assessment, the Cleanup of Brownfield Sites and the Filing of Records of Site Condition.

TABLES

Table 1-1
Proposed Risk-Based Target Criteria in Groundwater and Surface Water for Target Monitoring Stations

Chemicals of Potential Concern	Groundwater (ug/L)	Surface water (ug/L)
Vinyl Chloride	2	600
Diethyl Ether	50,000	165
1,1 Dichloroethane	9,000	200
Tetrahydrofuran	30,000	5,930
Benzene	1,900	100
1,4 Dioxane	50,000	20
Toluene	5,900	0.8
Chlorobenzene	500	1.3
m,p-Xylene	5,600	2
o-Xylene	5,600	40
1,1 Dichloroethene	7	40
cis 1,2 Dichloroethene	70	200
Chloroform	430	1.8
1,1,1 Trichloroethane	200	10
1,2 Dichloroethane	17	100
Trichloroethene	50	20
1,1,2 Trichloroethane	16,000	800
Tetrachloroethene	5	50

Source: Franz Environmental Inc, Former Gloucester Landfill Site, Risk-Based Environmental Quality Criteria, Updated October, 2003.

Table 1-2
Target, Trend, Performance Groundwater Monitoring Stations

	Target Monitoring			Trend Analysis			Performance Monitoring
Geological Level:	**Bedrock**	**Deep**	**Shallow**	**Bedrock**	**Deep**	**Shallow**	**Shallow**
SWP[1]							
	430A-D	437	318	431	47M5	47M17	
	424	420	357	432	37M11	37M17	
	419	421	135M16	433			
	434	423		37P3			
	435	413					
	436	135M9					
MWP[2]							
		70P1	70P3		202 B, C, D	202A	146
		71P1	71P2		203 B, C, D	203A	384
		423	328		204 A, B	383	311
		413	318			386	SW18
			357			309	307
						307	352
						355	201A
						304	
LCP[3]							
		70P1	70P3		202 B, C, D	202A	
		71P1	71P2			313	
		472	314			317	
			315			344	
						349	
						72P2	
						372	
						373	
Number of Stations:	6	9	8	4	5	17	
Number of Points:	9	9	8	4	10	17	

1. SWP: Special Waste Plume
2. MWP: Municipal Waste Plume
3. LCP: Leitrim/CP Rail Plume

Table 1-3
Target Surface Water Monitoring Stations

Plume	Target Monitoring
SWP	
	Ditch350
	Ditch362
	Albditch1
	Albs
	Ditch437
MWP	
	Ditch8
	Ditch7
	Ditch3
LCP	
	Ditch4
	LCPditch1 (New)
Number of Sampling Sites:	10

1. SWP: Special Waste Plume
2. MWP: Municipal Waster Plume
3. LCP: Leitrim/CP Rail Plume

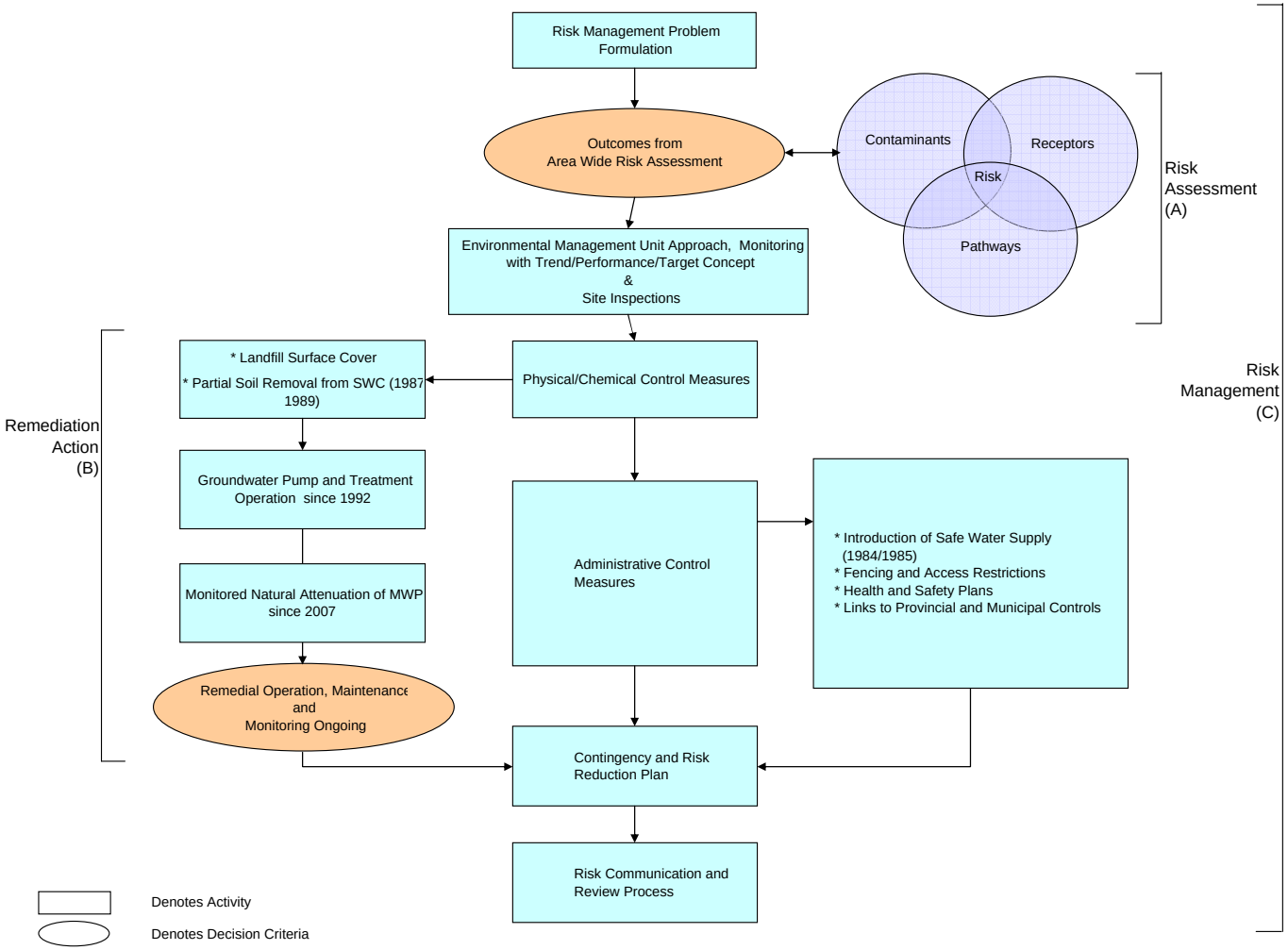
Table 1-4
Monitoring Stations within Each Environmental Management Unit

	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5
Target	437, 430, 420, 424, 421, 328, 318, 423, 413, 357, 419, 70P, 434, 435, 436, 135M	437, 430, 420, 424, 421, 328, 318, 423, 413	314, 315, 472	71P, 70P	-
Trend	202, 383, 386, 20M, 203, 309, 204, 307, 355, 304, 47M	-	349, 344, 72P, 372, 313, 373, 317	-	47M, 431, 432, 433, 37M, 37P3
Performance	146, 384, 311, SW18, 307, 352	-	-	-	201A
Ditch	Ditch3, Ditch8, Ditch7, Ditch3	Ditch7, Ditch3, Ditch437, Ditch362, Albditch1, Albs	LCPditch1	Ditch4, Ditch3	-

FIGURES

FIGURE 1-1

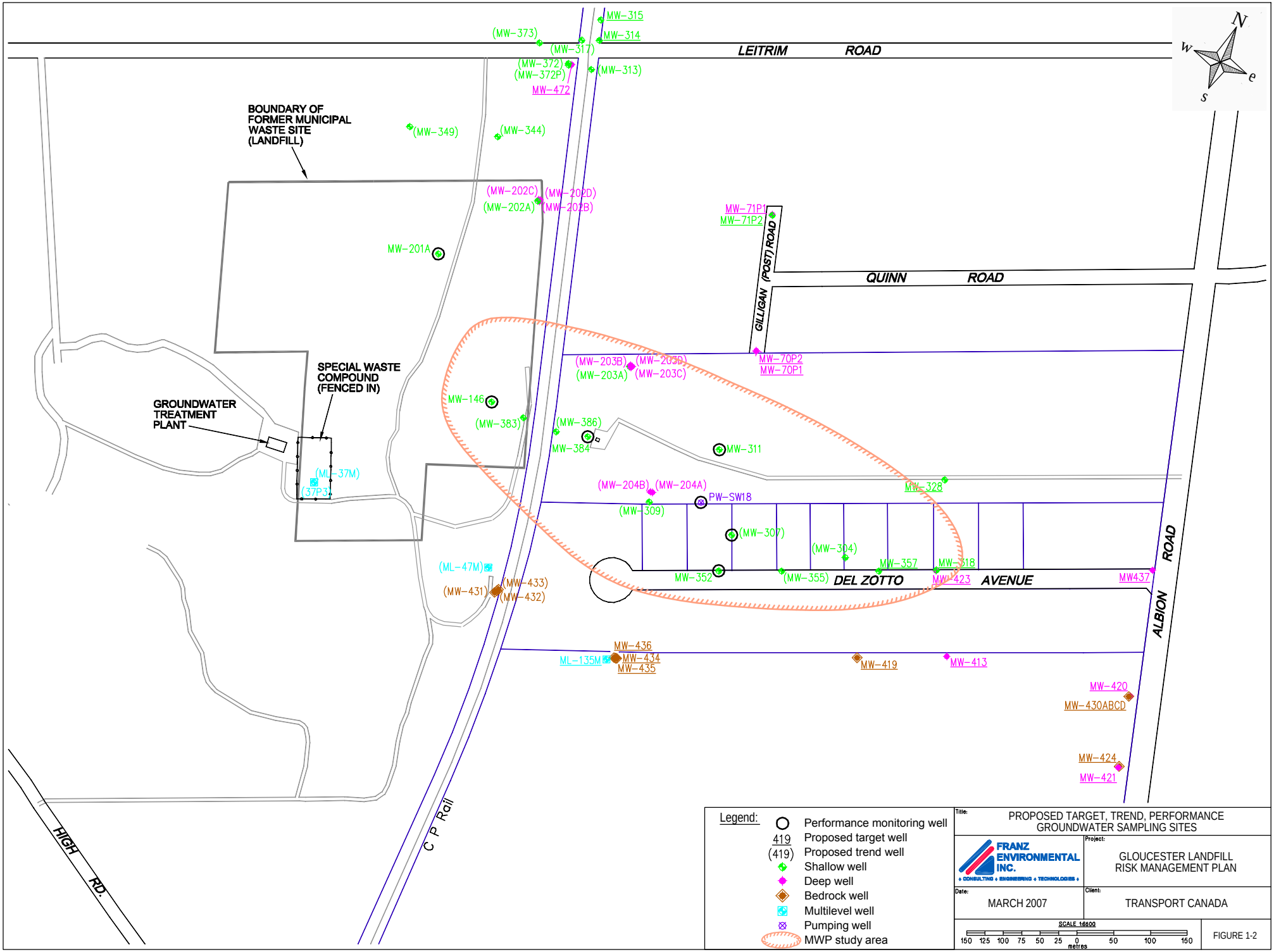
RISK MANAGEMENT PROCESS - SIMPLE MODEL



(A) Risk Assessment - A characterization of the nature, magnitude and potential for impacts on human health and ecological receptors from an operable exposure pathway.

(B) Remediation - The improvement of a contaminated site that involves removal or reduction of contaminant concentrations.

(C) Risk Management - Selection and implementation of a strategy of eliminating or controlling one or more risk assessment components.



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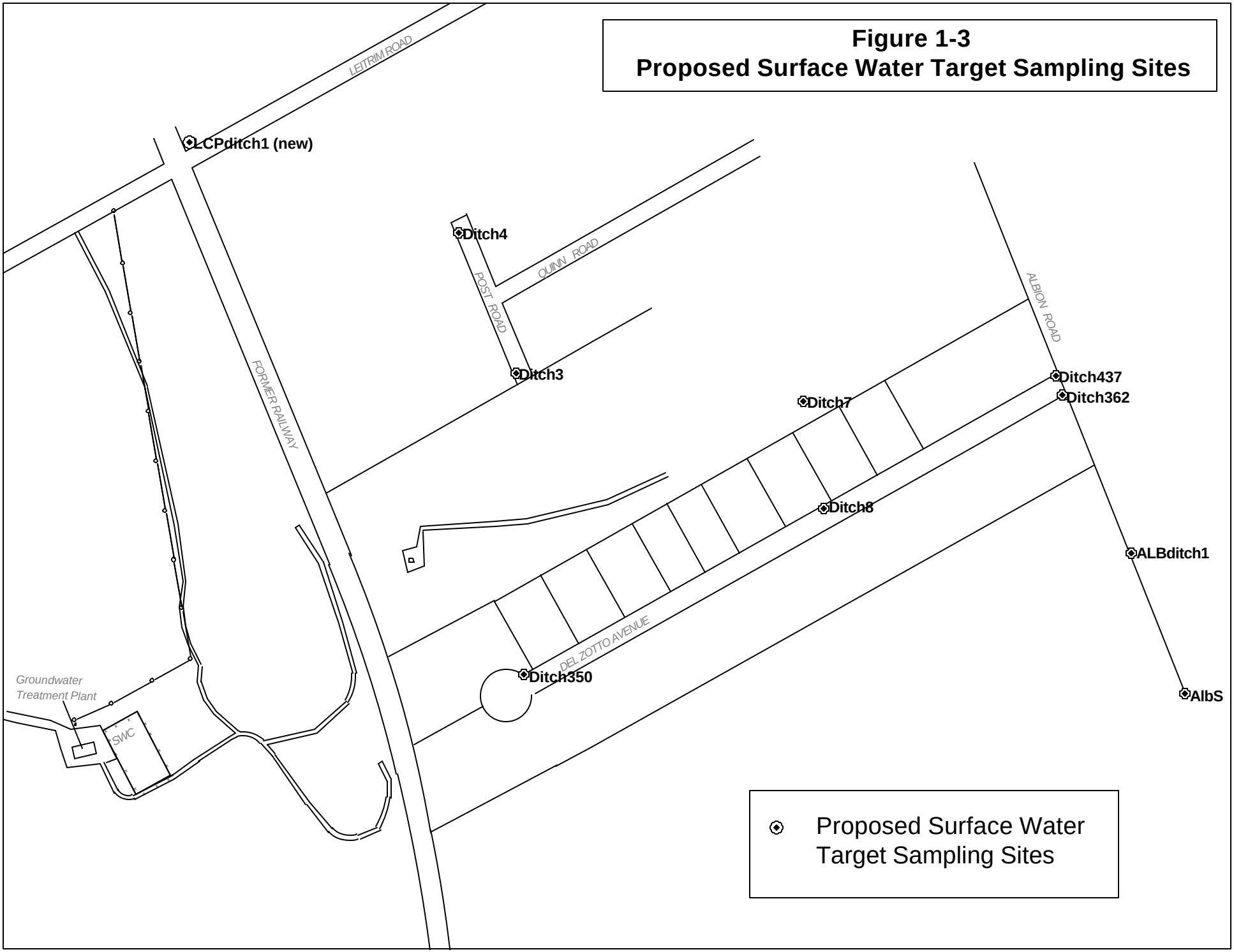
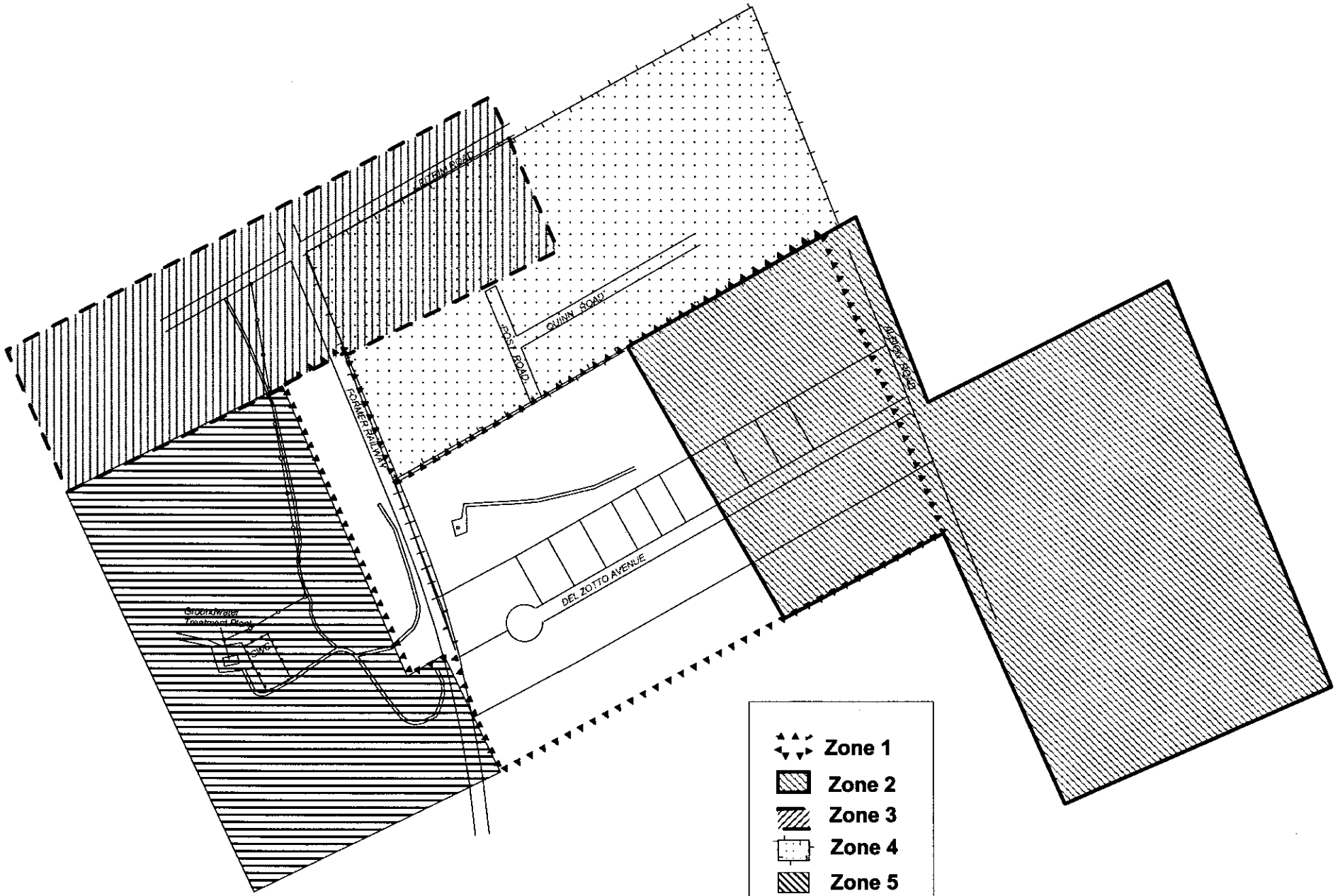


Figure 1-3
Proposed Surface Water Target Sampling Sites
LEITRIM ROAD
LCPditch1 (new)
Ditch4
QUINN ROAD
POST ROAD
Ditch3
FORMER RAILWAY
ALBION ROAD
Ditch437
Ditch362
Ditch7
Ditch8
ALBditch1
DEL ZOTTO AVENUE
Ditch350
AlbS
Groundwater
Treatment Plant
SWC
Proposed Surface Water
Target Sampling Sites

Figure 1-4
Environmental Management Units (i.e., Zones)



APPENDIX A

Appendix A: Example of moving average calculation

Table A-1 and Figure A-1 illustrate the concept of moving average and provide a comparison between moving average and individual concentration distribution.

Table A-1: Hypothetical Concentration Distribution and RBTC

Data ID	Sampling Date	Concentration (ug/L)	Moving average[1]	RBTC	Moving Average Exceed TB-TC (Y/N?)
1	Jan-98	2		1.25	-
2	May-98	3		1.25	-
3	Sep-98	0.5	1.83	1.25	Y
4	Jan-99	0.9	1.47	1.25	Y
5	May-99	1.1	0.83	1.25	N
6	Sep-99	0.25	0.75	1.25	N
7	Jan-00	1.6	0.98	1.25	N
8	May-00	0.7	0.85	1.25	N
9	Sep-00	1.1	1.13	1.25	N
10	Jan-01	0.25	0.68	1.25	N
11	May-01	1.6	0.98	1.25	N
12	Sep-01	1.1	0.98	1.25	N
13	Jan-02	0.25	0.98	1.25	N
14	May-02	1.6	0.98	1.25	N
15	Sep-02	0.7	0.85	1.25	N

1. Note: First Moving Average value comes from Data ID 1, 2, & 3. Second Moving Average value comes from Data ID 2, 3, &4 and so on.

Moving Average vs Individual Concentration - Example